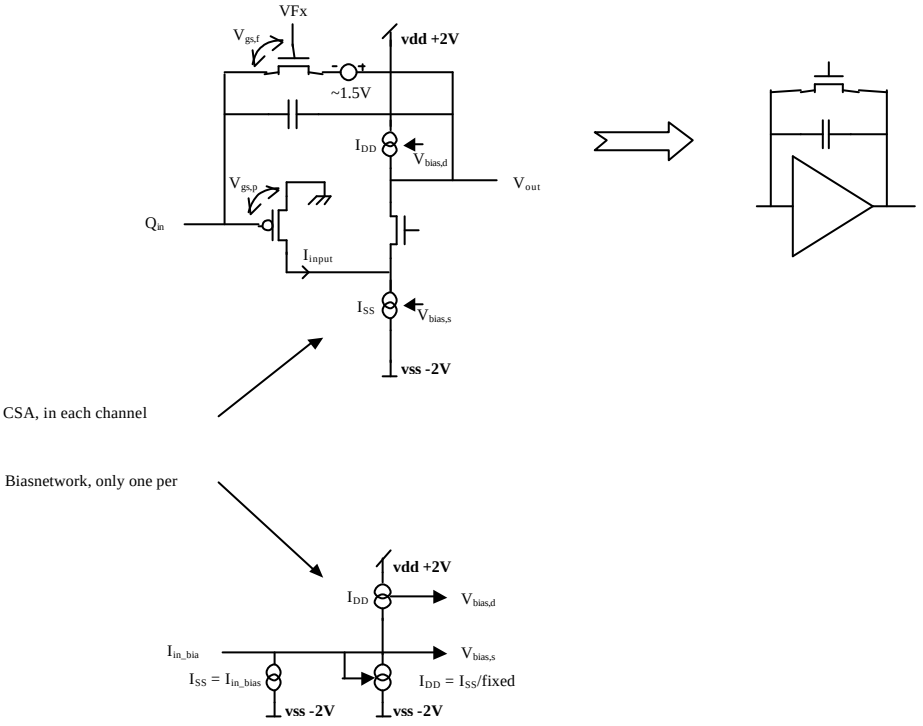
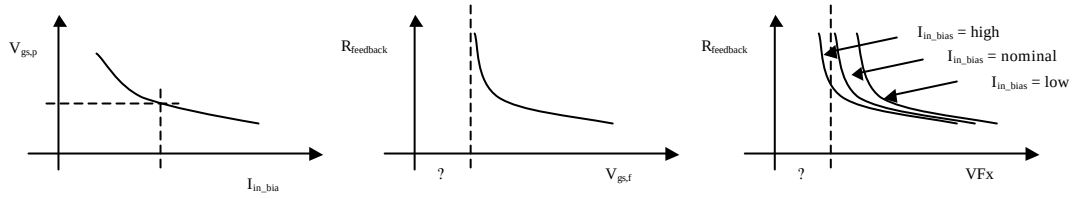
Biasing adjustments of a VA ASIC

Biasing adjustments of a VA ASIC, a brief explanation:

The internal principal structure of the Charge-Sensitive Operational Transconductance Amplifiers used in the VA-circuits:





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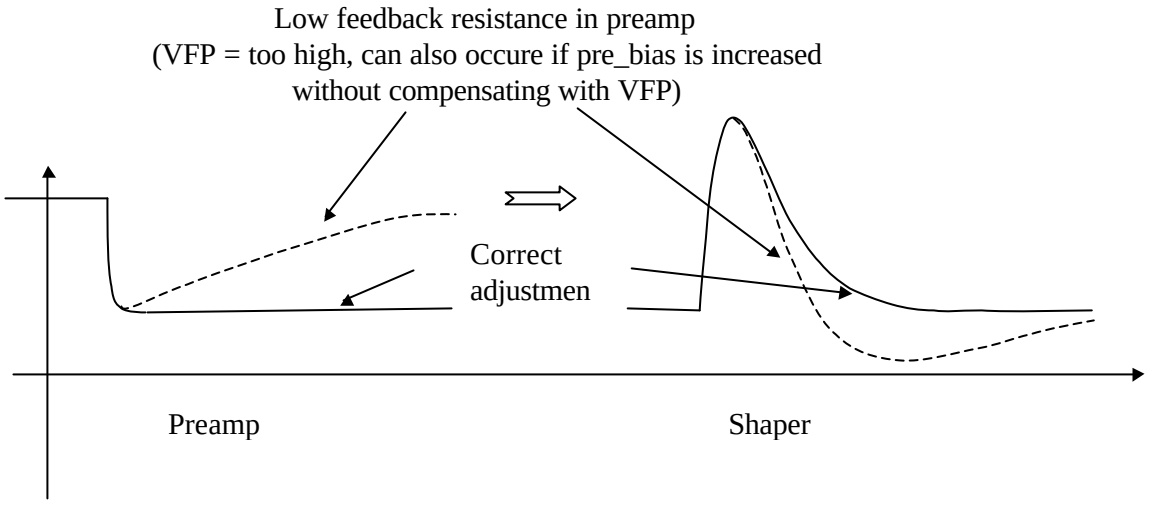
General comments to the adjustments of the amplifiers:

Both the preamplifier and the shaper can be adjusted externally by two control-pads which for the preamplifier are Vfp and pre_bias and for the shaper are Vfs and sha_bias, generally referred to as VFx and I_{in_bias} in the figures. Adjusting one will influence the affect of the other (preamp and shaper are totally independent though).

Changing e.g. pre_bias will change the dc-level of the input (since the Vgs of the input PMOS transistor has to increase/decrease as response to the change in current). This dc-level represents the source-voltage of the feedback NMOS transistor and with an unchanged Vfp, the Vgs of this transistor will consequently change. Therefore, to maintain the same resistance value, Vfs must change in correspondance to the change in the input dc-level caused by a change in pre_bias. Change in pre_bias will have no other visual effects on the signal-shape, but the noise will change.

Advices for optimising the preamplifier adjustments:

Set the pre_bias value to the desired value (usually the nominal). Then adjust Vfp starting from a high value (e.g. ground). The output of the shaper will in this case typically have an undershoot. Adjust it then downwards (negative values) until the signal disappears. Tune it then slowly up until the signal reappears. Tune it up another 50-100mV (to provide some margin). The output of the shaper should now have no undershoot. The feedback resistance is now almost infinitely large but it provides the necessary bias and it will with a long time-constant discharge the feedback-capacitor (so long that it will not affect the signal-shape in the shaper).



Changing the shape using the shaper adjustments:

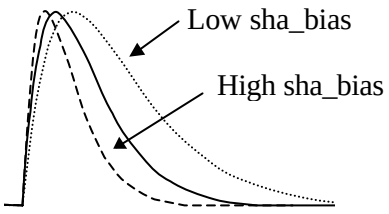
The preamplifier should first be properly adjusted. The signal shape should not be attemped changed by the preamplifier settings which only has one setting for a given pre_bias, the correct one.

Just like for the preamplifier, the sha_bias value will influence the dc-level of the input and hence the value of the feedback resistor (assuming the VFS is held constant). The shape will consequently be affected by this in two ways:

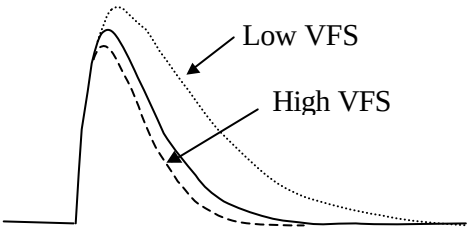
1. The change in feedback resistance will cause a change in the time-constant of discharding the feedback capacitor meaning that the differentiation time, or fall-time, will change. Reduced resistance (increase of sha_bias) will cause a shorter fall-time and vice versa.
2. Changing sha_bias will also affect the rise-time of the shape because the transconductance of the input transistor will change. Increase of sha_bias will cause faster rise-time and vice versa. Consequently, combining this with the previous point, an increase of sha_bias will increase the rise-time and decrease the fall-time which will reduce the peaking-time.

Only changing the VFS (keeping sha_bias constant) will affect only the fall-time but the effect will be stronger.

A good shape depends on the requirements. Nominally, the shape should be an ideal semigaussian CR-RC shape, but it doesn't necessarily be this. Generally, it is advantageous to minimize the "tail" of the signal (fall-time) since this part conserves the DC component og the signal and hence a long tail will make the amplifier more sensitive to the parallel noise (detector leakage-current noise and biasing-resistor noise).



Only adjusting sha_bias



Only adjusting VFS

Clearly, the desired shape will most often be found by adjusting both parameters.